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Analysis of quality of life across Tehran districts based on designated indicators and relational database management system

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ABSTRACT

Tehran's demography and urbanization have undergone dramatic changes since its designation as the capital city over two centuries ago. Currently, the city possesses 22 districts and a few associated regions (cemetery and southern suburbs).

We considered and developed 11 indicators to evaluate the quality of life of Tehran using Structured Query Language (SQL) algorithms. Indicators were classified into two large groups: 'population characteristics' and 'city features'. Except for literacy, sharp differences existed between the minimum and maximum values for each indicator. Noticeable differences in public transport were shown among districts. Comparison of the housing units with over 220 square meters size area among districts also revealed a difference between maximum and minimum values with a factor of 31, the per capita of greenery spaces and car parking capacities with a factor of 23.

Each indicator was considered individually to select districts having the most optimum condition. Between two and four indicators were also combined to nominate those districts with a higher number of indicators with optimum conditions. Our proposed approach and selected indicators showed high relevancy and appropriateness to assess quality of life in a typical large city.

Finally, we concluded the paper with practical and political remarks that may help streamline theories of urban governance into the actual conditions of urban dwellers across the world.

1. Introduction

Cities constitute people, infrastructure, institutions, and services (Khan & Zaman, 2018). In developing countries, massive investments have been made to accommodate their citizens in urban areas since the 1970s. It has caused unprecedented loss of lands and energy while enticing a rise in problems such as waste, crimes, and air pollution, among others. A so-called quality of life (QoL) has decreased, and urban residents' complaints have risen collectively. Urban parameters are in constant change, thus putting cities at risk of losing the quality of life and services. Those cities "that offer a low quality of life usually have limited growth relative to their potential" (UN-Habitat, 2020, p.12).

In this research, we evaluate QoL for Tehran. As the capital and largest city in Iran, the city has undergone unprecedented changes over the past decades (Rezvani-Naraghi & Amiraslani, 2020). With over 9 million (TM, 2019), Tehran's population growth has resulted from internal movement forces and rural-urban migrations. The city has also grown dramatically and chaotically in all directions, reaching over 730 km^2.

According to the definition proposed by Kaufmann and Sager (2019), Tehran could be regarded as a multifunctional capital city. Contemporary Tehran is a centralized and enlarged administration entity. It is now a capital city home to all ministerial offices, banks and insurers' headquarters, foreign embassies, national museums, and several public and private universities. Thus, this large apparatus has been embroiled with a large population, high dense buildings, low open spaces while facing many environmental and social challenges such as air pollution and crime.

Over the past decades, a range of methodologies have been used for the assessment of QoL; e.g., monetary quantification of the quality (D'Acci, 2019), logistic regression analysis (Weziak-Bialowolska, 2016); rankings assigned by the survey participants (Wong, 2001), etc. There are two major bottlenecks that this research intends to resolve. First, existing studies on QoL assess urban areas and pivot their debates based on a few urban factors such as housing value (D'Acci, 2019), density (Bardhan et al., 2015), local economy (Wong, 2001), and waste management (Baud et al., 2001). Second, QoL studies employ limited qualitative or quantitative scopes to evaluate selected parameters or only compare the conditions in various cities: e.g., data extracted from a survey (Weziak-Bialowolska, 2016), paper keywords (Papachristou & Rosas-Casals, 2019), covering one city district (Khaef & Zebardast, 2016).

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For Tehran, no holistic study has been conducted to assess QoL. The existing studies have covered very limited districts, scopes and indicators, e.g., one neighborhood only (Khaef & Zebardast, 2016), pedestrian areas in one district (Samavati & Ranjbar, 2017), three districts (Kazemzadeh-Zow et al., 2018), housing (Zebardast, 2009), greenways (Shahani, 2013), and health-related issues (Tourani et al., 2018).

Based on these research gaps in global literature on QoL, we contemplated our research inquiry surrounding two aims: First, to explore the usability of a novel data-driven approach to analyze multicriteria scenarios in evaluating QoL using the Structured Query Language (SQL), as the first known attempt. Second, to implement a comprehensive QoL study to cover all Tehran 'districts'. We will describe our primary dataset extracted from the Tehran Municipality report (TM, 2019) and the SQL methodology in Section 2. Using existing global indicators set for the QoL and developing new indicators, we will use our data-driven approach to verify its reliability while analyzing Tehran's current situation (Section 3), followed by further analysis of the findings in Section 4.

2. Data and methods

2.1. Dataset

This research utilized a report released by Tehran Municipality in 2019 (TM, 2019). This 598-page report, in the Persian language, illustrated detailed and updated data on nearly every aspect of the city, from the population to transport to the economy. There is no proxy with such comprehensive numerical details for each Tehran district. The report encompasses other associated regions based on their urban management definitions (e.g., cemetery), but we will focus only on 22 districts as liveable areas in this research. In addition to international literature, we used a few Persian language references, mainly for data references and cross-checking. However, as these references are not readable and accessible for international readers, we did not refer to them individually in the text to avoid unnecessarily referencing (Hereafter 'domestic research'). The reference detail will be displayed in case of the usage of substantial materials from these Persian references.

2.2. Selection of indicators

A variety of indicators are used, individually or combined, to evaluate QoL globally. For instance, housing value, density, local economy, and waste management (D'Acci, 2019; Weziak-Bialowolska, 2016; Bardhan et al., 2015; Baud et al., 2001; Wong, 2001) have been used in other research papers. However, the Tehran Municipality report, *per se*, does not provide a list of such indicators for assessing QoL. As such, we selected a few of its indicators primarily based on our data needs as described here. We must acknowledge that applying all indicators in one study could not be feasible, given the unavailability of data in all countries. We selected some of the global indicators based on our data availability and developed new relevant indicators. Eleven selected/defined indicators were classified into two large groups: population characteristics and city features. We provided logical statements to support the inclusion of indicators for this research (Table 1).

2.3. Data analysis using SQL

We extracted raw data corresponding to each indicator from the Tehran Municipality report (TM, 2019) and entered them into a spreadsheet. In some cases, we had to sum up figures scattered in different places in the original report. For instance, according to their rendering company, the report separates taxi numbers, but we collated them under the one indicator ('taxi') as a proxy of the Public transport'.

As an organized collection of data stored in rows (records) and columns (fields) of different tables, a database is being utilized chiefly by businesses and health care systems due to their massive and diverse type of collated data. A relational database management system (RDBMS) is utilized to explore hidden and apparent relationships among these data. One can obtain the required information scattered across various tables using various user-defined queries. Queries are being directed to one or multiple tables simultaneously to extract required data, using algorithms, rules, filters, constraints, and commands of the Structured Query Language (SQL) software (Arvanitis et al., 2000; Viescas & & Hernandez, 2007).

The application of digital data in urban studies is mounting. From finding streets on digital maps to use crowdsourced data to profile urban places (e.g., Lai et al., 2020), digital data have become the forefront of new urban studies. Given an increase in digital data generated by social media and remote sensing platforms, the inclination toward managing such big data is rising. Therefore, digital database management systems (e.g., SQL) could be the solution for analysing these large datasets. So far, however, utilization of structured Query Language (SQL) in urban studies has been rare. Only one study has used SQL algorithms to analyze geographical patterns of traffic congestion in Beijing (Zhao & & Hu, 2019). Elsewhere, this approach has been used for assessing urban environmental issues through the lens of media analysis (Amiraslani & & Caiserman, 2018; Amiraslani & & Dragovich, 2021a, 2021b).

Such an SQL-based technique has an advantage in urban studies compared to traditional methods. For instance, by combining indicators, we developed a query to reveal the hidden relationship between four indicators (Greenery spaces AND newly developed zones AND literacy AND population density) in this research. The existing traditional approaches cannot establish links between such unrelated urban indicators (e.g., Literacy and Greenery spaces), especially if we encounter thousands of records and several fields. Without SQL coding in place, extracting such multiple inquiries would not be feasible, highlighting the advantages of our approach.

3. Results

3.1. Statistical analysis of indicators

We calculated certain statistical variables (Min, Max, Mean, SD) for each QoL indicator (Table 2). We noticed considerable variations (SD) among Tehran districts. For instance, the number of units with over 220 m2 showed a high SD among districts. It could be expected for Tehran as its large size units typically exist in certain districts.

3.2. Assessment of districts corresponding to each indicator

Each indicator was considered individually. Then, we made a query using SQL algorithms to extract those districts ('Resulted districts' column) which could respond to the most optimum condition defined for each indicator ('Description' column) (Table 3).

As is evident in Table 3, the highest percentage (64%) was recorded only for the 'population density and 'old building zones' indicators. Each of the 'fire incidents' and 'public complaints' indicators included 59% of districts followed by 'daily travels' and 'newly developed zones' indicators with 54% and 50%, respectively. Four indicators were ranked below the average. Each of the 'literacy' and 'public transport' indicators included 45% of the total districts, followed by the 'car parking' indicator (36%). The worst situation (32%) was related to the 'greenery spaces' indicator.

3.3. Assessment of districts based on the combination of indicators

At this stage, we combined two or more indicators. The premise was to evaluate the hidden meaningful relationships that existed among indicators using SQL algorithms. Anyone can stipulate that there would be an apparent relationship between taxis and daily travels. But what about daily travel and new development areas? Or what about daily travel, taxis, and new development areas? Therefore, by providing the logic and using SQL algorithms, we crossed two and more indicators to

Table 1
Indicators for the quality of life (extracted from the literature or developed in this research).

Group	Indicator	Logic	Source	Remarks
Population characteristics	Literacy	Higher literacy rate may be a critical factor in selecting better residential areas with higher living standards	[1; 2]	also called: 'Level of education' [1]
	Daily travel		[3]	also called: 'Average journey per car' [3]
	Size area over 220	Larger size areas of houses need high quality of urban amenities and infrastructure (e.g., traffic systems, heating systems)	*This research*	
City features	Fire incidents	Lower fire incidents may be correlated to better construction materials, higher standards utilities, higher building fire safeties	*This research*	
	Greenery spaces	Higher greenery spaces are cited as one of the key determinants of housing prices and qualities	[1; 2; 3; 4]	
	Public complaints	Less public complaints reveal better urban conditions	[1]	also called: 'Quality of governmental services and the rule of law' [1]
	Old building zones	Those zones with old buildings are congested, with lower urban life qualities and higher air pollution	*This research*	
	Car parking	Urban citizens feel less burdensome to find suitable parking places for their cars while street traffic jams will be eased	*This research*	
	Public transport		[1; 2; 3; 4]	
	Newly developed housing		[3; 4]	
	Population density		[1]	

1: Weziak-Bialowolska (2016); **2:** Bardhan et al. (2015)); **3:** Wong (2001); **4:** D'Acci (2019)

Table 2
Descriptive and statistical features of quality of life indicators.

Row	Indicator	SQL-based coding variable	Description (per district)	Unit	Min	Max	Mean	SD
1	Literacy	*Literacy*	Literacy rate of residents	%	86	99	90.54	3.56
2	Daily travels	*Dail_Tra*	Number of daily travels	Person/year	120080	967331	419650.72	221141
3	Size area over 220 m^2	*Over220*	Number of units with an area over 220 m^2	Year	258	8110	2798.72	2507.21
4	Fire incidents	*Fire_inc*	Number of reported fire incidents	Year	229	1859	921.77	473.69
5	Greenery spaces	*Per_Cap_GS*	Area of greenery spaces per capita	M^2	2.58	58.67	16.44	13.25
6	Public complaints	*Complaints*	Number of complaining calls	Year	717	3056	1422	706.01
7	Old building zones	*Old_fab*	Area of old building zones	Ha	1	593	148.68	157.33
8	Car parking	*Park_Cap*	Number of car park capacities	Vehicle	821	19491	4991.59	4364.53
9	Public transport	*Taxi*	Number of taxis with designated route	Vehicle	0	2016	862.36	769.05
10	Newly developed housing	*Dev_units*	Number of newly built units	Year	2538	15764	7984.33	3320.23
11	Population density	*Pop_dens*	Number of people per area unit	Ha	34	412	184.09	102.25

explore relationships among *old_fab* and *literacy, new_dev* and *literacy, complaints* and *literacy, Per_Cap_GS* and *literacy, Per_Cap_GS* and *old_fab, Per_Cap_GS and new_dev, Dail_tra* and *taxi*. Here, 11 relationship matrices consisting of two to four indicators resulted. 'Selected districts' were nominated for each combined scenario according to the optimum conditions (Table 4).

4. Discussion

4.1. Unjust balance between the 'North' and 'South'

Growing from its small area, Tehran has gradually incorporated adjacent areas (including villages) and been expanded fast. The city has absorbed surrounding areas to create 22 districts with varied shapes, size areas, and urban amenities. One domestic research incorporates Tehran districts within three co-centric nested zones based on their geographical locations: central (historical), intermediate and peripheral (marginalized) zones (Haghighatnaeini & Rabieifar, 2015). According to their research, the central zones have fewer greenery spaces, lower per-capita shares of educational and health amenities, old-fabric housing, and ineffective transport systems. These have led these central parts to experience a high crime rate and social abnormalities (e.g., D10, D11, D12 in our research). The intermediate zones experience unpleasant urban landscapes, high housing density, and high air pollution due to traffic jams (e.g., D6, D7 in our research). The peripheral zones include high polluting industries, have low per-capita shares of educational and health amenities, destructed natural landscapes, landfills, and waste treatment areas (e.g., D18, D19, D20 in our research). This zonal classification conforms with the overall physical expansion of Tehran that occurred over the past decades. This classification also depicts the overall gloomy conditions for Tehran, delineating inappropriate urban planning and functionalities. This improper planning has resulted in asymmetrical population density be formed between the southern and northern spheres. A study shows that the Tehran northern sphere contributed to over 58% of the total population, while the southern sphere had 20% (Ghadami & Newman, 2017).

4.2. Descriptive and statistical features of indicators

As is apparent in Table 2, there are distinctive statistical variations among districts corresponding to each indicator across Tehran (see column 'SD'). Except for literacy, sharp differences exist between 'min and max' values for each indicator. In particular, districts showed a highlighted difference in public transport. Here, we used taxi as a proxy for public transport. While a few districts have no such routine taxi services, one district encompasses 2016 taxis as the maximum recorded number. Also, the zone area covering old buildings show huge gaps varying between 1 and 593 ha. The comparison of housing units, over 220 m^2, among districts also reveals a difference between maximum and minimum values with a factor of 31, the per capita of greenery spaces and car parking capacities with a factor of 23 (Table 2). In our research, 'public complaints' were categorized as one of the indicators. The Tehran Municipality report shows that these complaints included urban services, transport and traffic, urban planning and architecture, urban develop-

Table 3
Assessment of Tehran districts corresponding to each of the eleven indicators.

Indicator	Description	Resulted districts	Percentage to the total districts
Population density	Districts with a population density lower than the mean value	D1, D2, D3, D4, D5, D6, D9, D12, D16, D18, D19, D20, D21, D22	64%
Old buildings zones	Districts with a lower than average share of old buildings	D1, D2, D3, D4, D5, D6, D8, D9, D13, D18, D19, D20, D21, D22	64%
Fire incidents	Districts with reported fire incidents lower than the mean value	D3, D6, D7, D8, D9, D10, D11, D13, D14, D16, D17, D21, D22	59%
Public complaints	Districts with public complaints lower than the mean value	D6, D8, D9, D10, D11, D13, D16, D17, D18, D19, D20, D21, D22	59%
Daily travel	Districts with daily travel lower than the mean value	D7, D9, D10, D11, D13, D16, D17, D18, D19, D20, D21, D22	54%
Newly-developed zones	Districts with a higher than average share of newly-developed buildings	D1, D2, D3, D4, D5, D7, D8, D10, D11, D14, D15	50%
Literacy	Districts with a literacy rate higher than the mean value	D1, D2, D3, D4, D5, D6, D7, D11, D13, D21	45%
Public transport	Districts with a higher than average share of public transport (taxi in this research)	D1, D2, D3, D4, D5, D7, D8, D15, D19, D20	45%
Car parking	Districts with a higher than average share of car parking spaces	D1, D5, D7, D9, D11, D12, D17, D22	36%
Greenery spaces	Districts with per capita greenery spaces higher than the mean value	D1, D2, D4, D19, D20, D21, D22	32%

ment, social and cultural, financial, human resources, among others (TM, 2019). For instance, people used a wide range of communication tools (email, phone, internet, etc.) to complain about diverse problems, from park lighting to delays in public transport to waste management (TM, 2019). Therefore, the inclusion of the 'public complaint' indicator could improve the cumulative performance for studying QoL (e.g., districts 'D6, D11, D13, D21' in our research).

4.3. Inclusivity of indicators

The rankings of districts based on each indicator (Table 3) reveal mixed results, varying from 64% to 32%, for each indicator. Those districts responding to the higher number of nominated indicators are summarized in Table 5.

Districts mentioned by 7 indicators (out of 11 indicators): (D1, D21, D22)

It is not surprising to see D1 categorized in this group. District D1 is the most expensive northern district for its land and unit prices in Tehran (and even in the country). This district's high prices of land and housing units (D1) result from accessible surrounding mountainous landscapes, relicts of old Tehran gardens, water flowing, etc. It was one of the oldest villages (Tajrish) surrounding Tehran 100 years ago but has been gradually merged to Tehran. It had once the most significant public and private gardens in Tehran. The district is bounded to Alborz mountainous flank in the north, and this physical limitation has prevented land developers from further encroachment. Moreover, Tehran city council rules prohibit building development in areas with altitudes higher than 1800 m above sea level.

In contrast, both D21 and D22 districts are the newest developments in Tehran, heading toward the west of Tehran. They encompass one of the most significant newly developed areas and are not physically restricted. This western zone connects Tehran province to the adjacent Alborz province as the only possible zone with open space enough to expand.

Districts mentioned by 6 indicators (out of 11 indicators): (D2, D3, D4, D5, D7, D9, D11, D19, D20)

The majority of these districts are parts of Tehran's old fabrics. This group includes districts home to the affluent (D2, D3), middle-class (D4, D5, D7), and poor (D11, D19, D20) inhabitants. However, we could not find a plausible explanation for these nominations. Districts 2 and 3 are classified as expensive districts in terms of land and unit prices. Despite costly building prices in D2 and D3, these districts are prone to earthquakes due to being adjacent to Alborz mountainous flank. On the other side of the land valuation spectrum, districts 19, 20 have the cheapest land and unit prices. District D5 includes a well-known residential building development in west Tehran called 'Ekbatan'. It was the first large-scale high-rise building complex, designed by a South Korean architect, the local architecture firm, Gruzen Partnership, and an American firm in the 1970s (Mashayekhi, 2019). They include apartments for 15,500 middle-class families located east of the Mehrabad International Airport (Mashayekhi, 2019). After half a century, this residential area still includes high-quality buildings.

Districts mentioned by 5 indicators (out of 11 indictors): (D8)

D8 was the only district that was mentioned by five indicators. It is located in the eastern flank of Tehran, adjacent to surrounding open spaces. According to the Municipality report, this district encompasses a mixed share of old and new buildings.

Districts mentioned by 4 indicators (out of 11 indictors): (D6, D10, D16, D17, D18)

Districts D10, D16, D17 and D18 are located in the southern flank of Tehran. They usually include a dense population with less access to high-quality services and amenities. These districts suffer from the existence of old-fabric buildings, high crimes and environmental challenges. In contrast, D6, with a size area of 2144 hectares (3% of Tehran area), is located in Tehran's central parts. It includes high price houses and trade centers (including dense administration entities with a diverse range of services). According to domestic research, D6 hosts headquarters of 33% of ministerial offices, 28% of higher education institutes, 19% of major hospitals, and significant Iranian insuring companies.

Districts mentioned by 2 indicators (out of 11 indictors): (D12, D14, D15)

At the bottom of our research ranking lie these three districts, which were mentioned by two indicators. These are densely populated districts with very low-quality facilities and amenities. Table 6 exemplifies a well-known neighborhood located in D12. It demonstrates the density of land uses with a low share of greenery spaces and sports facilities.

However, we must clarify that such classification may detract readers from real situations, especially in one case: literacy. As shown in Table 2, literacy rates across Tehran districts are relatively high, varying between 86% and 99%. So, classifying districts based on 'below or above the mean value' may mislead readers by these relative values.

4.4. Combined indicators

Table 4 depicts a clearer picture of contemporary Tehran. Over one-third (36%) of districts were not included in any combined indicators

Table 4
Districts selected based on the combination of two or more indicators.

Combined indicators	Number of indicators	SQL Expression	Logic	Selected districts
Old buildings zones **and** literacy	2	*old_fab* < mean AND *literacy* > mean	Citizens with a higher literacy rate may choose to live in the older city zones with better access to existing infrastructure (road) and services (e.g., public transport)	D1, D2, D3, D4, D5, D6, D13, D21
Newly developed zones **and** literacy	2	*new_dev* > mean AND *literacy* > mean	Younger generations are willing to live in zones with higher numbers of newly developed buildings (as they possess their cars for commuting, use new smart technologies for shopping, etc)	D1, D2, D3, D4, D5, D7, D11
Greenery spaces **and** old buildings zones	2	*Per_Cap_GS* > mean AND *old_fab* < mean	Citizens may choose to live in the older city zones with better access to existing infrastructure (road), services (e.g., public transport) and higher greenery spaces	D1, D2, D4, D19, D20, D21, D22
Daily travels **and** size area over 220	2	*Dail_Tra* > mean AND *over220* > mean	Affluent families live in larger houses and may possess more cars and are busier than others; this means more daily travels	D1, D2, D3, D4, D5, D6
Public complaints **and** literacy	2	*Complaints* < mean AND *literacy* > mean	Citizens with a higher literacy rate are either very busy (have no time to complain or inquire from public organizations) or understand the procedural complexities (prolonged bureaucratic and administrative procedures)	D6, D11, D13, D21
Greenery spaces **and** literacy	2	*Per_Cap_GS* > mean AND *literacy* > mean	Citizens with a higher literacy rate prefer to live in zones with higher greenery spaces	D1, D2, D4, D21
Greenery spaces **and** newly developed zones	2	*Per_Cap_GS* > mean AND *new_dev* > mean	Younger generations are willing to live in zones with higher numbers of newly developed buildings and larger greenery spaces	D1, D2, D4
Greenery spaces **and** newly developed zones **and** size area over 220	3	*Per_Cap_GS* > mean AND *new_dev* > mean AND *over220* > mean	Affluent families purchase houses in newly built zones with higher greenery spaces and larger houses	D1, D2, D4
Greenery spaces **and** newly developed zones **and** literacy	3	*Per_Cap_GS* > mean AND *new_dev* > mean AND *Literacy* > mean	Affluent families who purchase houses in newly developed zones with higher greenery spaces have higher literacy rate	D1, D2, D4
Greenery spaces **and** newly developed zones **and** size area over 220 **and** population density	4	*Per_Cap_GS* > mean AND *new_dev* > mean AND *over220* > mean AND *Pop_dens* < mean	Affluent families purchase houses in less dense newly developed zones with higher greenery spaces and larger houses	D1, D2, D4
Greenery spaces **and** newly developed zones **and** literacy **and** population density	4	*Per_Cap_GS* > mean AND *new_dev* > mean AND *Literacy*> mean AND *Pop_dens* < mean	Affluent families who purchase houses in less dense newly developed zones with higher greenery spaces have higher literacy rate	D1, D2, D4

Table 5
Selected districts responding to higher numbers of indicators.

No. of nominations	Districts	Urban features
7	D1, D21, D22	D1 is the most expensive northern district; D21 and D22 are the newest developments
6	D2, D3, D4, D5, D7, D9, D11, D19, D20	Including most old fabrics areas in Tehran
5	D8	Eastern Tehran (mixture of old and new buildings)
4	D6, D10, D16, D17, D18	Southern and Central Tehran; old-fabric buildings, higher crimes and environmental challenges
2	D12, D14, D15	Densely populated districts

Table 6
Land uses in one of neighborhoods located in district D12.

Land use	Area (m^2)	% of the total area	Land use	Area (m^2)	% of the total area
Residential	229394	58	Industrial areas	9115	2
Businesses	61275	15.5	Health services	2727	0.7
Roads and pedestrian	43373	11	car parking	2023	0.5
Barren lands	19888	5	Sports facilities	983	0.25
Education	15512	4	Greenery spaces	792	0.2
Others	9737	2.85	**Total**	**394819**	**100**

Source: Modified after Bavand consultancy firm (cited by Hataminejad et al., 2018).

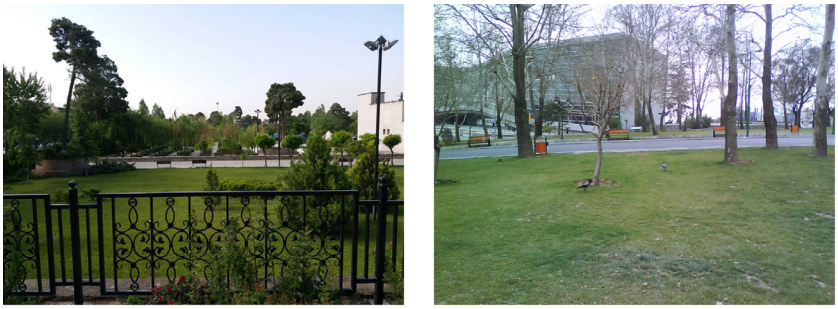

Fig. 1. Typical public greenery spaces in Tehran. *Left*: This land lot in district D7 is a repurposed infamous old prison; *Right*: A well-known old park, Park Mellat, located in district D3; the building shown in the photo is a multi-purpose building added to the park a few years ago (Photos by the author)

(D8, D9, D10, D12, D14, D15, D16, D17, D18). Typically, these districts encompass impoverished neighborhoods with less favorable economic, environmental, and social conditions such as residents' literacy, population density, greenery spaces, and daily travels. Research reveals that such districts have a density of over 300 persons per hectare as the densest area in Tehran (Ghadami & Newman, 2017). A few of these districts host the most significant concentration of old shopping markets and educational centers in Tehran. However, most of these properties may be owned by the affluent people who live in high-quality districts or are regarded as public and cultural assets with no hope of being demolished or refurbished. Therefore, these dense districts are covered less by greenery spaces and a few new-built developments.

On the contrary, districts D1, D2 and D4 dominated each row of combined indicators. For instance, the combination of four indicators (Greenery spaces AND Newly developed zones AND Literacy AND Population density) showed that these three districts (D1, D2 and D4) were only nominated ones. Indeed, these three districts accommodate the most affluent population who benefit from a luxury lifestyle and income (including larger houses and a more significant number of private cars).

4.5. Greenery spaces

We demonstrated earlier that only one-third of districts were classified under the optimum 'greenery spaces' indicator (Table 3). The overall per capita ratio of greenery spaces in Tehran has improved dramatically and reached 16.27 m^2 over the past three decades (TM, 2019). There have been efforts to refurbish the parks, remove iron bars all around the parks, and oust garrisons and prisons from Tehran city and repurpose their land lots into parks. A new addition to the Tehran parks is multi-purposed buildings that include cinemas and thematic spaces (Fig. 1).

For further analysis on greenery spaces, we compared two types of data across districts: Decadal changes and Yearly differences:

Decadal Changes (2008–2018): We compared the ratio of change (%) of greenery spaces between 2008 and 2018 using two Persian reports published by Tehran Municipality (TM, 2008, 2019). A noticeable decadal change (%) could be observed across all districts varied from 87% to 441% (An average of 177%). It is a considerable improvement, given that Tehran encompasses limited public open spaces to be used for such purposes. However, this does not necessarily mean that all districts have gained proportionate improvement. We found out that D1 (441%), D9 (371%) and D21 (297%) had undergone the most significant greenery improvement. D1 and D21 could be attributed to their proximity to surrounding open spaces that provide more available plantation spaces. The improvement in D9 could be due to an internal re-plantation and park creation. The lowest change in greenery spaces was observed for D16 (87%).

Yearly differences (2018): A comparison of the ratio between D4 (the highest) and D16 (the lowest) revealed massive differences by a factor of 80. Unsurprisingly, D19, D20 and D22 were shown only in one combined case (high greenery spaces and low old-fabric buildings). These three districts are knitted to the open areas adjacent to Tehran, where the expansion of greenery spaces is feasible. Our above findings concerning combined indicators were similar to another domestic research in which Tehran districts were classified according to Human Development Indices.

Nevertheless, Tehran has lost much of its open spaces over the past decades. According to a recent study conducted to evaluate the land consumption in 40 cities using satellite imagery, Tehran comprised 54.8% compact areas, followed by 35.54% industrial and 9.66% open areas (Hu et al., 2021). Compared with Moscow's land consumption ratio, another capital city, where open areas consist of 86%, followed by 11.25% industrial and 2.75% compact areas (Hu et al., 2021), a noticeable contrast between these two capital cities is apparent.

4.6. Research limitations

Despite recent improvements in public data availability, especially in developing countries, citizens face difficulties accessing some data types (e.g., public *versus* open data: Attard et al., 2015). Like other research, we faced limitations in accessing data. For instance, global research considers other indicators for evaluating QoL, such as health services, cost of living, and housing prices. We could not access such indicators or their proxies for Tehran city. Urban public transport systems, whether smart or conventional, typically consist of buses, subways, and taxis. Here, we did not have access to records of other transport systems, and thus taxi was used as a proxy for public transport.

4.7. Practical and policy implications

Municipalities usually have access to inadequate resources and information for urban planning. Moreover, the physical growth of cities is bounded by other obstacles, including low private investment, geographical restrictions, inefficient bureaucracy, and limited updated data (e.g., Maj-Waśniowska & Jedynak, 2020; UN-Habitat, 2010). Such obstacles could not be resolved overnight, but any initiative, like this research, to reveal hidden or apparent relationships among urban parameters could provide insights and directions for future urban plans.

In line with the sustainability notion, the concept of future desirable cities comprises various labels such as smart cities (Khan & Zaman, 2018). Our proposed SQL-based data analysis methodology can be considered a promising approach to dealing with rising digital metadata in assessing such newly defined cities. This research showed how unrelated urban parameters (e.g., taxi versus new development areas) might contribute insight to improve urban transportation. Indirectly, more efficient urban transportation could reduce carbon emissions and create better air quality, in line with 'low carbon' cities. We also showed how greenery areas could be combined with other urban factors contributing to the growing concept of 'resilient' cities.

Globally, even cities with high quality of life are facing "significant challenges in providing safe and adequate housing for urban residents" (UN-Habitat, 2020, p.59). By combining indicators, we highlighted the tendency of residents of different age groups to live in new or old development areas, an urban research trend labeled as 'age-friendly' cities.

4.8. Quality of life in the context of urban governance

Urban governance involves multiple governmental and non-governmental actors (Hendriks, 2014). Moreover, approaches to urban governance are changing rapidly in response to the challenges of the 21st century (da Cruz et al., 2019). In this paper, we strived to address some of these urban governance concerns while assessing quality of life for Tehran.

Studies suggest that 'citizen participation (individual citizens) in decision making' (da Cruz et al., 2019) is regarded the first challenge in urban governance. We addressed this issue through adding a new indicator (public complaints), a proxy for this challenge. The 'government capability' is the third nominated challenge of urban governance (da Cruz et al., 2019), and so, we incorporated two indicators to address it: greenery spaces and public transport. The issue of 'private sector delivery of public services' (da Cruz et al., 2019) is another challenge for urban governance. This research dealt with this subject by incorporating two indicators: car parking and daily travel. The essence of the new paradigm in urban governance is pivoted on digital governance (Meijer et al., 2019). Here, we described a data-driven approach to assess the quality of life. Given rising urban digital data, findings of this research paper can open another avenue for improving urban governance in a more effective digital way.

5. Conclusion

Tehran formation, expansion and functionality have undergone noticeable alterations over the past decades. Tehran's socio-economic and political journey from being a remote small village in nowhere to a summer resort for royals to a vast modern capital city has been fascinating. The city has seen remarkable events, inhabitants, and predicaments.

We revealed that none of the earlier classic or autocratic urban plans that started in the early 20th century had the foresight to uphold such unprecedented changes made afterwards. By the early 1960s, the city was growing in every direction completely unregulated (Mashayekhi, 2019) and has continued to grow in the same trend since then.

Relying on descriptive evidence, existing reliable datasets, and database management technology, we assessed the QoL across 22 contemporary Tehran districts. We employed a data-driven approach to evaluating districts using 11 indicators, both individually and combined. Noticeable differences exist among 22 districts in Tehran. Our research findings are verified by another domestic research, noting that no single district could be nominated as the best or worst district regarding the QoL.

Our proposed approach and selected indicators showed high relevancy and appropriateness to assess life quality in a typical large city. SQL-based combined queries proved beneficial to consider various (unrelated) indicators for ranking urban districts. Our research was the first to identify the relationship between unrelated indicators (e.g., taxis *versus* new development areas) that may provide different value-added combinations to the existing literature. As the development of new areas in Tehran is unavoidable, such untested combinations (taxis and new development areas) could provide further knowledge for transport planning in Tehran.

Our data-driven approach could be a testament for incorporating accurate raw data, urban knowledge, and database techniques to be employed in other case studies in the Middle East region and further afield. Applying this model in other urban settings is recommended to provide a higher degree of certainty of this model's reliability.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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